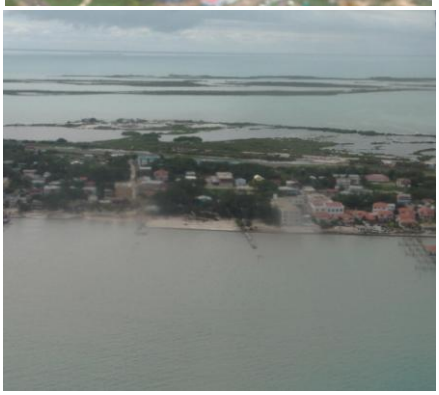
NATIONAL EMERGENCY MANAGEMENT ORGANIZATION

Damage Assessment and Needs Analysis (DANA) Committee

INITIAL DAMAGE ASSESSMENT REPORT



HURRICANE EARL, August 3rd & 4th, 2016

BELIZE C. A.

Damage Assessment and Needs Analysis Committee
Initial Damage and Loss Assessment (IDA)
As at September 22nd, 2016

Contents

List of Tables

List of Figures

List of Annexes

Introduction

This Initial Damage Assessment is aimed at determining relief and immediate response requirements and is conducted immediately in the early and critical stage of a disaster, and as soon as the conditions allow survey teams to operate. The characteristic of such an assessment is that it is broad in scope and focuses on overall patterns and trends. It identifies:

1. The magnitude of the disaster (without delivering exact figures)
2. The impact of a disaster on the society
3. People's capacity to cope
4. The most urgent relief needs and potential methods of delivery
5. Priorities for action
6. The utilization of resources for immediate response
7. The need for detailed assessment of specific geographical areas or substantive sectors
8. The level of continuing or emerging threats
9. The need for international assistance

The damage and losses here reflect information compiled from: surveys done by district DANA teams and central field teams, district emergency coordinators and emergency committees, district sources such as village councils, aerial reconnaissance, sectoral surveys conducted by other NEMO committees or respective Government Ministries, and through the application of baseline data.

The Initial Damage Assessment Report is preceded by a Preliminary Situation Report, which is prepared during the first 8 hours after the all clear has been issued. The Preliminary Situation Report is an interim report intended for internal purposes only and is used to inform NEMO's immediate recovery and relief efforts. This Initial Damage and Loss Assessment report is to be followed by a Detailed Sectoral Report which should be finalized within 3 months of the date of the all clear issued by NEMO.

Preface

This report was prepared by the ***Damage Assessment and Needs Analysis (DANA) Committee*** of the ***National Emergency Management Organization (NEMO)*** for the Government of Belize, following the damage created by the passage of Hurricane Earl on August 3rd, 2016. The report was prepared as a direct request by the Prime Minister of Belize, the Rt. Honourable Dean O. Barrow, through the NEMO, in an effort to record and document hurricane impacts, in order to inform the recovery efforts and quantify the loss to GDP and quality of life of its citizens. The objective of this report is to capture the damages created by the passage of Category 1 Hurricane Earl, which passed across central Belize on a west-north west track on the 4th August, 2016.

The report is designed to comprehensively assess the overall sectoral damages with recommendations on recovery, rehabilitation, and reconstruction. This report was prepared through coordination and cooperation of key ministries, private sector and non-governmental organizations.

It is important to note that the report was designed to capture the sectoral damage of assets, resources and infrastructure, loss to revenues along with the strain on the psychological and sociological condition of the affected citizens in the immediate and medium term. This is an important note because health; physical, environmental and psychological; is the most difficult to measure or quantify, but is an important element in the restoration of the country to conduct its post-disaster development track.

Every disaster creates an opportunity for our nation to improve its current rudimentary systems reconstruct with modern technology and climate resilient practices.

Limitations of Assessment

There was a temporary lapse in communication between District DANA teams and the DANA ***Emergency Operation Center (EOC)*** due to hurricane damages on the national utilities such as electricity and telecommunications. While it was the intention of the DANA teams to provide prompt damage assessment information to the EOC, lack of electricity, telephone and internet service resulted in some delays. The availability of sufficient and adequate vehicles with trained field staff with which to cover the broad area of the impact was also a challenge.

Post storm commitment of the key committees is difficult to maintain, as the business of government needs to continue. Therefore, there is a natural attrition to move from emergency mode to serving the public, which leaves key positions in the committees incapacitated. It is important that the personnel within this structure are evaluated so that there is a cross-training and organized replacement in place for post-disaster and the gradual transition to the normal services provided by the Government.

1.0 EXECUTIVE SUMMARY

The National Emergency Management Organization (NEMO) was activated on Sunday 31st July, 2016 to respond to the potential threat from a strong and fast moving Tropical Wave in the Eastern Caribbean. The National Damage Assessment and Needs Analysis (DANA) Committee was activated on Monday 1st August, 2016 in preparation for the tropical cyclone, which later became Hurricane Earl that made landfall on the night of Wednesday, 3rd August 2016. Hurricane Earl made landfall South of Belize City as a Category 1 hurricane, with estimated maximum sustained winds of 80 mph and recorded storm surge up to 9 feet. Hurricane Earl had a wide area of influence and took 15 hours to fully cross the country. The major areas affected were primarily the Belize, Orange Walk, Cayo, and Stann Creek Districts.

The Total Economic Impact across the Social, Productive, Infrastructure and Environmental, Fisheries and Forests Sectors is estimated to be BZD$188,678,394.

There were no recorded deaths caused by Hurricane Earl; however, a total of 3,109 households, comprised of 6,733 adults and 5,454 children, were impacted. The total estimated damages to the Social Sectors of Belize are estimated to be BZD$22,180,063 and are broken down as follows: damages to the Housing Sector are estimated at BZD$17,795,814; damages to the Education Sector are approximately BZ$317,485; damages to the Health Sector were estimated to be BZD$3,750,714; and damage to Historical and Cultural sites is estimated to be BZD$316,050.

The Productive Sectors of Belize suffered the greatest damages that are estimated to be BZD$124,472,264 and are broken down as follows: the estimated total damage to the agricultural sector is BZD$76,698,713; the total economic impact of Hurricane Earl on our Hotel Sector, including loss of revenue from overnight tourist expenditure, tour operators and Cruise is estimated at BZD$31,926,420; the total loss to the Aquaculture and Capture Fisheries sector was estimated to be BZD$15,847,131.

The total estimated damages to Infrastructure are estimated to be BZD$31,547,258 and are broken down as follows: the total damages to the Electricity sector were estimated to be BZD$10,000,000; the total damages to the Telecommunications sector were estimated to be BZD$1,783,363; the total damages to roads and bridges were estimated to be BZD$2,944,695; the total damages to piers is estimated to be BZD$16,819,200.

The total estimated damages to the Environment and Forestry Sectors of Belize are estimated to be BZD$10,478,809 and are broken down as follows: the total in damages to the Forests and Natural Vegetation is estimated to be BZD$7,360,000; the total estimated cost for Environmental Goods and Services is estimated to be BZD$1,406,260; the total damage to Marine and Coastal Habitat was estimated at BZD$1,712,549.

Hurricane Earl has significantly affected the areas of Agriculture, Tourism, and Housing, and a financing mechanism is therefore critical in efforts to allow these sectors to recover. In particular the Productive

Sector has received the largest amount of loss and requires intervention for a speedy recovery so its contribution to the Belize Economy can be realized.

2.0 BACKGROUND

2.1 The Mission

The ***National Damage Assessment and Needs Analysis (DANA) Committee*** is charged with the coordination of the resources needed to rapidly assess the damage caused by a disaster; to prepare an immediate assessment of the damage; and to assess damages in all areas in order to enable the ***National Emergency Management Organization (NEMO)*** to make short, medium, and long term requests for assistance from local and foreign sources.

The National DANA Committee was activated Monday 1st August, 2016 in preparation for the tropical cyclone which was later to become Hurricane Earl. District DANA teams were operational during the time that Hurricane Earl made landfall Wednesday 3rd August 2016 and at the time the all clear was issued on Thursday 4th August 2016. Preliminary field information was collated from a fly-over on Thursday 4th August 2016 by a multidisciplinary team as well as field-based assessments by the District DANA teams. Additional field teams were dispatched Monday 8th August 2016 to conduct initial damage assessments in all districts except Toledo. The information used to prepare this report is from data collected up to 7 days after the **"ALL CLEAR"** had been issued.

2.2 Description of the Phenomenon and their Effects

(Source: NEMO/Belize Meteorological Office)
On Sunday 31st July, 2016 a strong and fast moving Tropical Wave entered the Eastern Caribbean. NEMO was activated on Sunday 31st July, 2016 to respond to the potential threat from the Tropical Wave. Initial track projections pointed to a path due north of Belize City. On Wednesday August 3rd Earl attained Category 1 status with winds of 75 mph. Hurricane Earl made landfall early Thursday morning near Belize City as a Category 1 hurricane, with estimated maximum sustained winds of 80 mph and recorded storm surge up to 9 feet. The track changed before making landfall, placing it south of Belize City as shown in Figure 1.

The system took about 15 hours to fully cross the country. Hurricane Earl had a wide area of influence as shown in Figure 2 but the major areas affected are primarily Belize City, Belize Rural, Orange Walk, Cayo, and the Stann Creek Districts. NEMO declared the "**ALL CLEAR"** for Belize on Thursday, 4th August at 9:00 a.m.

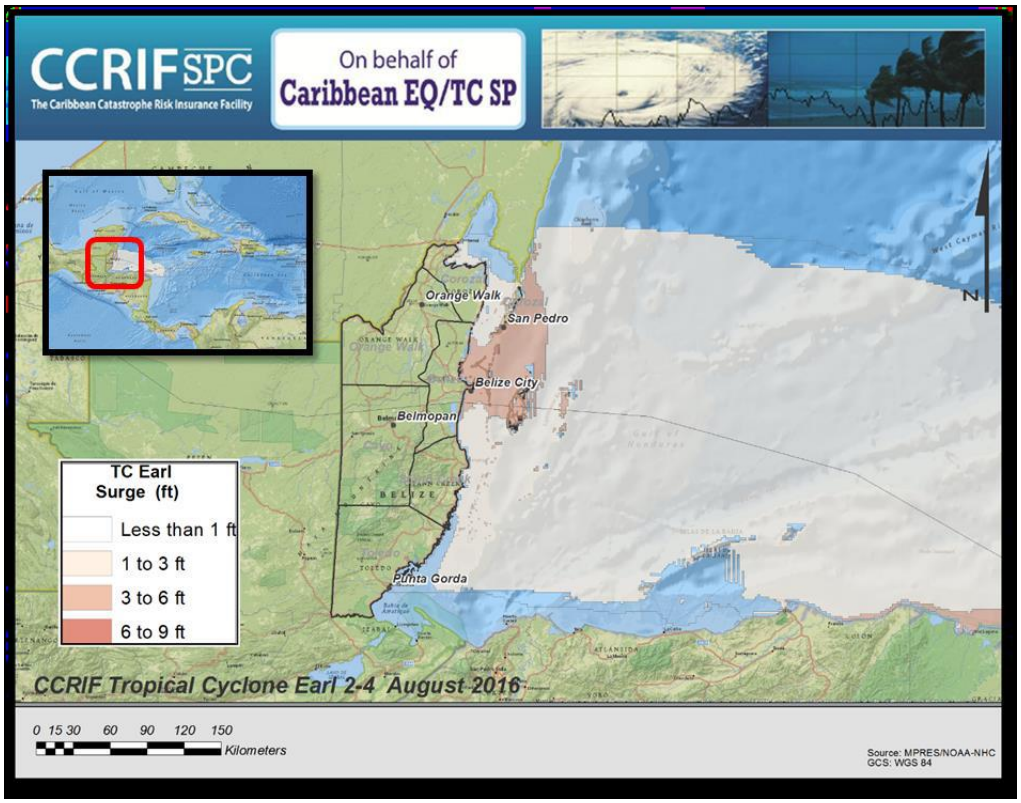


Figure 1: Map showing the path and surge field associated with Hurricane Earl
(Source: NHC, CCRIF/MPRES)

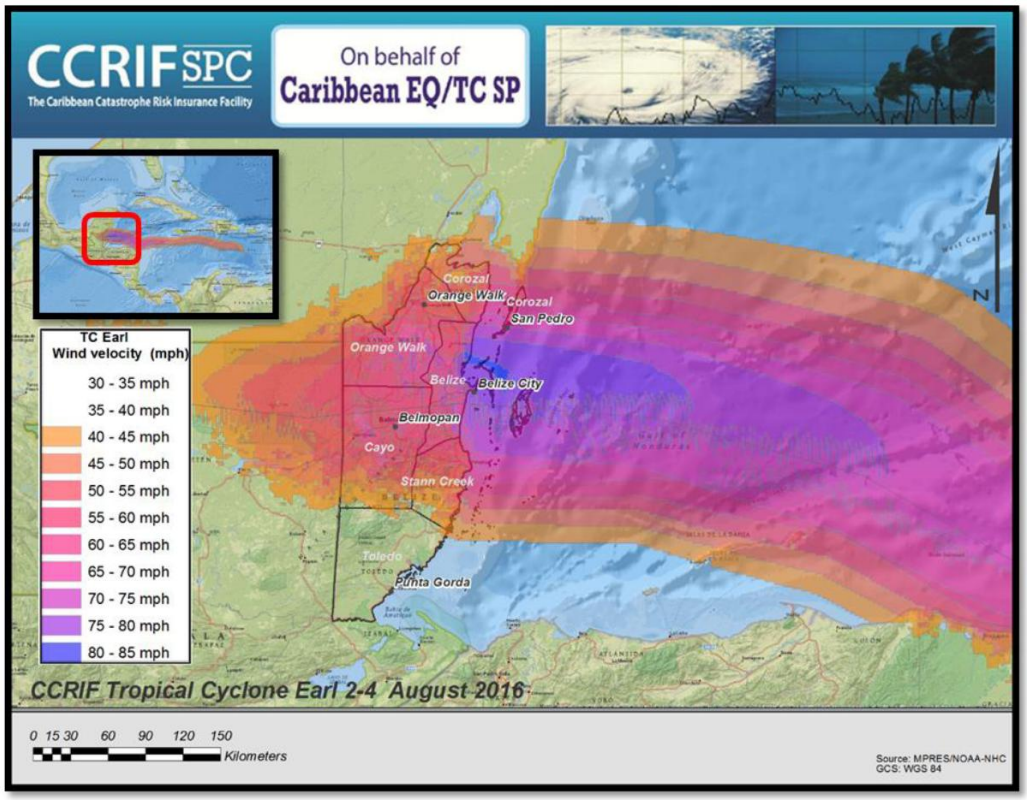


Figure 2: Map showing the path and wind field associated with Hurricane Earl
(Source: NHC, CCRIF/MPRES)

2.3 Description of Affected Population

(Source: Ministry of Human Development, Annex 1)
There are no recorded deaths or injuries associated with the passage of the storm system. To date, 119 people remain in shelters in the Belize, Cayo and Orange Walk Districts: 56 in Belize City; 13 in Belize Rural; 46 throughout Cayo communities; and 4 in Orange Walk.

The communities with highest impacts were mostly in the **Belize District**, inclusive of San Pedro, Caye Caulker; the Belize Rural communities of Ladyville, Willows Bank, Rancho Dolores, Isabella Bank, Double Head Cabbage, Sandhill, Biscayne Village, Lords Bank, Maskall, Lucky Strike, Boston, Santana, Bomba, Crooked Tree, Hattieville, Gales Point and La Democracia. Communities affected in the **Cayo District** are Spanish Lookout, Springfield, Armenia, Valley of Peace, St. Matthews, Cotton Tree, Teakettle, Ontario, Camalote and Blackman Eddy.

To a lesser extent communities in the Orange Walk and Stann Creek Districts experienced damage. Those communities affected in the **Orange Walk District** are Indian Creek, Guinea Grass, Chan Pine Ridge, San Felipe, Indian Church, and Santa Martha. In **Stann Creek District**, the communities affected were Dangriga, Bladen, Valley Community, Sarawee, Hope Creek Village, Placencia Peninsula, San Carlos, Independence, Cowpen, Red Bank, Maya Mopan, San Roman, Maya Center, Sittee River, Santa Cruz and Bella Vista. **Corozal District** suffered some losses in the agriculture sector.

The **National Relief and Supplies Management Committee (RSMC)** has been in full operation since the *All Clear* was given on August 4, 2016. RSMC have been conducting household assessments and the corresponding distribution of relief supplies in the affected areas. **As of 7pm on Thursday 11th August, a total of 3,109 household assessments** have been done translating to 6,733 adults and 5,454 children, a total of 12,187 people see Table 1.

	Households assessed	**Adults**	**Children (0-17yrs)**	**Total per District**
Belize City	1,262	2,727	2,156	**4,883**
Belize Rural	1,143	2,520	1,923	**4,443**
San Pedro	46	110	61	**171**
Belmopan*	497	1,014	1,011	**2,025**
Stann Creek	132	280	252	**532**
Orange Walk	34	82	51	**133**
Total	**3,068**	**6,733**	**5,454**	**12,187**

*Belmopan includes Cayo South constituency

Table 1: Affected households assessed countrywide

An additional 20 households have been assessed in Santa Elena/San Ignacio and surrounding villages while 28 households were assessed in Caye Caulker with a total of 83 people; detailed results are pending. The RSMC assessed households to determine the presence of vulnerable persons such as those showing signs of post traumatic stress; anxiety and early symptoms of trauma such as marked changes in eating and sleeping habits and nightmares. Likewise, the presence of persons within these households with chronic illnesses, disabilities or other special needs was also noted. Some of that information is presented in Table 2 but further assessments are still ongoing.

	Lactating	**Pregnant**	**Psychological Concerns**	**Special Needs**
Belize City	129	47	123	286
Belize Rural	80	44	183	241
Belmopan*	46	6	0	Pending
Cayo	Pending	pending	pending	Pending
Stann Creek	14	5	0	pending
Orange Walk	2	0	0	pending
Total	**271**	**102**	**306**	**527**

*Belmopan includes Cayo South constituency

Table 2: Vulnerable population

2.4 Emergency Actions

2.4.1 Government Actions

(Source: Ministry of Human Development and NEMO, Annexes 1 and 2)
The Relief and Supplies Management Committee (RSMC) have assisted approximately 1,580 households or about 8,000 people in the Belize, Stann Creek, Cayo, Orange Walk Districts and San Pedro/Caye Caulker. **1,200 households assisted in the Belize District**: Belize City, Vista Del Mar, Ladyville, Lords Bank, Sand Hill, La Democracia, Gracie Rock, Hattieville, Western Pines and Freetown Sibun. **123 households assisted in Stann Creek**; **226 households in Belmopan and the surrounding communities**; **23 households assisted in Orange Walk** and **10 households in San Pedro & Caye Caulker**. These numbers are likely to grow.

A total of **BZD$2,606,979** has been spent on providing food packs and drinking water, cleaning supplies, mattress and bedding materials, relief equipment and supplies, roofing materials, and transportation and rental of heavy equipment (*source: NEMO*). This cost is also inclusive of food and hot meals provided for persons seeking shelter during and after the Hurricane and to the Emergency Operations Center personnel. The RSMC estimates that it has completed assessments and distributions in 90% of affected

areas. RSMC continues the outreach operations in the affected communities with food, water, tarp/plastic sheeting, cleaning supplies, mattress etc.

2.4.2 International Cooperation

BATSUB, BDF and UNICEF have been assisting people in the shelters. The Belize Red Cross and USAID are supporting NEMO with field operations.

3.0 ASSESSMENT OF THE DAMAGE

This section includes a summary of the total damages by sector, including social sectors, productive sectors, infrastructure, and environment, fisheries, and forest. The total damages experienced by Hurricane Earl have been estimated so far at **BZD$188,678,394**. The breakdown by sector and sub-sector can be found in Table 3.

Summary of Damages (BZD$)	
Social Sectors	**22,180,063**
Housing	17,795,814
Education	317,485
Health	3,750,714
Historical/Cultural Sites	316,050
Productive Sectors	**124,472,264**
Agriculture	76,698,713
Tourism	31,926,420
Aquaculture/Capture Fisheries	15,847,131
Infrastructure	**31,547,258**
Public Utilities	11,783,363
Roads and Bridges	2,944,695
Piers	16,819,200
Environment, Fisheries and Forest	**10,478,809**
Marine and Coastal Habitat	1,712,549
Forest and Natural Vegetation	7,360,000
Environmental Goods and Services	1,406,260
TOTAL	**188,678,394**

Table 3: Summary of Damages

3.1 Social Sectors

3.1.1 Housing

(*Source: Preliminary fly-over, District DANA Reports, and District Emergency Committees and Coordinators; Annex 3*)

There were impacts of Hurricane Earl on the housing sector in several communities. These communities are listed below by District.

- **Belize District**: Belize City, Ambergris Caye, Caye Caulker, Ladyville, Lord's Bank, Sand Hill, Maskall, Burrell Boom, the Belize River Valley communities, Hattieville, Crooked Tree, Biscayne, Gales Point, and Gardenia
- **Cayo District**: Belmopan, St. Matthews, Cotton Tree, Buena Vista, Blackman Eddy, Santa Familia, Carmelita, Roaring Creek, Camalote, Benque Viejo, San Ignacio and Santa Elena, and Santa Martha

- **Stann Creek District**: Dangriga, Hope Creek, Red Bank, Sarawee, Maya Center, San Roman, Santa Rosa, Mullin's River, and Maya Mopan
- **Orange Walk District**: Carmelita, Guinea Grass, New Hope, Indian Church, San Carlos, San Felipe, Fireburn, Trial Farm, San Juan, Douglas, August Pine Ridge, and Indian Creek

The damage assessment to the housing sector included structural damage with levels ranging from 1 to 4. Level 1 is assigned to structures for which there was *no significant damage*, Level 2 for those that had minor damage (*structure is usable and can be occupied after urgent temporary measures are taken*), Level 3 for those with major structural damage (*structures are not usable and cannot be occupied until after repairs are made*), and Level 4 which is assigned to structures completely *destroyed*.

A total of 1,099 houses were documented. 860 or 78.3% of the structures assessed were made of metal (zinc) roof with timber or plywood walls; 202 or 18.4% were made of metal (zinc) metal roof with concrete walls; the remaining 5 or 3.3% were thatched structures. These experienced damages at all levels from 1-4. A summary of the damages by District and some individual villages and municipalities are presented in Table 4 below. Based on the figures presented in Table 3 the locality with the greatest impact was **Belize City** with an estimated damage to housing of **BZD$5.6 million**. The total damages to the housing sector are estimated at **BZD$17,795,814**.

District	Community	Level 1	Level 2	Level 3	Level 4	Total	Cost (BZD$)
Belize	Ambergris Caye/ Caye Caulker	48	51	20	7	126	1,973,700
	Belize City	96	127	69	39	331	5,625,338
	Belize Rural	136	97	38	26	329	3,991,388
Cayo	Belmopan	1	15	31		47	1,10,925
	Cayo Rural	40	33	3	15	91	1,328,175
Stann Creek	Stann Creek		32	58	40	130	3,810,713
Orange Walk	Orange Walk	7	4	30	4	45	1,066,500
TOTAL		**328**	**359**	**249**	**131**	**1099**	**17,795,814**

Table 4: Summary of Damages to Housing

3.1.2 Education

(Source: Ministry of Education, Annex 4)

Hurricane Earl caused significant damage to some schools in the education sector. Table 5 provides a list of schools and preliminary estimated value of damages to building infrastructure. 41 schools were damaged – 2 preschools, 27 primary schools and 12 secondary schools. These schools serve

approximately 11,000 students. The estimated cost of damages is approximately **BZ$318,000.00**. The full assessment of damage to equipment, furniture, materials and other assets is ongoing.

Damages were experienced primarily to schools in the Belize and Cayo Districts; though the Northern Districts (Orange Walk and Corozal) and the Southern Districts (Stann Creek and Toledo) reported minor damages to schools. The impacts of these damages will affect the capacity to reopen and resume classes on the normal dates and thus the school year may need to be extended to address the issue of lost instructional time. To date, after consulting with school managements, no reports of damages to equipment and materials have been received.

In addition, two of Belize National Library Service and Information System (BNLSIS) community libraries in the Orange Walk District received damages due to Hurricane Earl totalling approximately BZ$11,250.00, as shown in Table 5 below.

DISTRICT SCHOOLS	**ESTIMATED DAMAGES**
Belize District – Urban; *18 schools*	$189,600
Belize District – Rural; *15 schools*	$90,185
Orange Walk – Rural; *1 school*	$10,000
Cayo District – Urban; *2 schools*	$3,300
Cayo District – Rural; *5 schools*	$24,400.00
TOTAL	**$317,485**

Table 5: Preliminary estimated value of damages to affected schools by District

3.1.3 Health

(*Source: Ministry of Health, Annex 5*)
The damage assessment for the health sector was conducted by Rapid Response Teams (RRT) post Hurricane Earl and immediately after the all clear was issued by NEMO. Information collected was done through observations on the ground; in the communities; from emergency field workers including shelter managers and community workers; and from the media.

The main areas of health concern were: vector control, drinking water quality, nutrition, mental health, and public health programs.

Vector control: many areas remain inundated by flood waters or stagnant water leaving the Belizean population vulnerable to possible outbreaks of vector diseases, which include dengue fever, malaria,

Chikungunya, and Zika. There is also a high possibility of skin infection, acute respiratory illnesses, hepatitis A, cholera and leptospirosis - many of these are synonymous with post-disaster situations.

Drinking water quality: Key populations' drinking water sources are inundated with flooded waters containing overflows from septic tanks and latrines posing significant risk for contamination by chemicals and transmission of pathogens. Some of the major sources of water, for example the Belize River, remains under flood conditions making the risk for the transmission of waterborne illness very high in the absence of proper treatment of water systems and maintenance of appropriate chlorine residuals. As the flood waters move further downstream, other areas that were not previously flooded now face having their potable water source contaminated and unavailable. These risks are greater for those communities located alongside the Belize River.

Nutrition: Nutritional status of the population living in the affected areas, particularly those living in flooded areas and where crops for domestic consumption were destroyed, will continue to be monitored.

Mental Health: The true impact of Hurricane Earl on mental health is still indeterminate; however preliminary reports indicate that there is significant need for psychosocial intervention in the affected populations. The socioeconomic conditions will be of particular concern in this respect as people move from "survival" to "normal" mode of functioning.

Public Health Programs: Surveillance is vital in the entire post disaster health response process. The loss of 3 servers for the Belize National Health Information System (BHIS) is impeding access to real time health data and the generation of alerts to the medical staff that needs to take immediate action. This setback can definitely lead to the non-detection of outbreaks in the community and result in increased cost to the government for the provision of medical care to affected individuals.

Structural Damages: Damage to health facilities were reported in Belize City, Caye Caulker and the City of Belmopan. Cleopatra White Polyclinic (CWP) and Karl Heusner Memorial Hospital (KHMH) in Belize City reported water damage. CWP and KHMH experienced minimal damage to their roof. Caye Caulker Health Center has reported some damage to their zinc roof.

In the City of Belmopan, the Western Regional Hospital (WRH) reported some damage to the roof. Secondary threats are possible at this facility due to the composition of the roof.

Key concerns that currently remain for the health sector hinge on overall public health post-disaster

1. Post Traumatic Stress Disease in affected families in the central health region
2. Water quality and analysis of same in flooded areas up to now (Western and Central Health Regions)
3. Potential spikes in acute respiratory illnesses, gastrointestinal and skin infections
4. Potential Outbreak of mosquito borne illnesses – Zika, dengue, malaria and Chikungunya

It is expected that secondary effects on the health sector may be felt within the next 4 months. These effects relate to the water-borne and other diseases mentioned above. In preparation for the influx of these diseases and in order for the Government of Belize to adequately respond to these events, it is proposed that the Government of Belize procures the requisite materials and equipment to serve the general public at medical service centers, conduct post surveillance vector control, and rehabilitate health facilities. The total estimated cost is **BZD$3,750,715** as outlined below in Table 6.

Activity	**Cost in US$**
Medical Supplies	243,529
Pharmaceuticals	434,718
Post Surveillance Vector Control	238,310
Health Facilities Rehabilitation Cost Estimate	958,800
GRAND TOTAL IN USD$	**1,875,357**
GRAND TOTAL IN BZD$	**3,750,714**

Table 6: Budget Summary Post Earl Surveillance and Medical Care

3.1.4 Historic/ Cultural Sites

(*Source: Ministry of Youth, Sports and Culture, Annex 6*)
The ***National Institute for Culture and History (NICH)*** conducted an assessment of structural damage to modern tourism facilities, cultural structures, trail systems and access routes. NICH also conducted an assessment of timeframes and costs to restore the opening of archaeological parks, since these parks are critical revenue streams.

The rapid assessments revealed limited or no structural damages to tourism facilities and cultural structures. The largest impacts were fallen trees on trails, plazas and within tourism zones. The most heavily impacted sites were Lamanai, Altun Ha and No Hoch Cheen Archaeological Parks. These sites provide critical revenue streams. Therefore, decisive decisions were made to hire personnel to clear access routes and to allow for the reopening of archaeological parks. During the clean-up campaign, many tourism volunteers came out and assisted NICH with staff and equipment until all critical routes and trails were cleared to critical tourism attractions within the reserves. It must be noted that the Orange Walk tourism stakeholders sent over 50 persons to help with the clearing of Lamanai. Other tourism stakeholders were at Cahal Pech, Caracol, No Hoch Cheen and ATM; allowing for the quick reopening of several archaeological parks in 3 to 5 days, except for Xunantunich due to flooding. The primary archaeological parks that are most visited were reopened in record time and normally would have taken 2

to 3 weeks. Other sites, such as Barton Creek, ATM and Caracol, will require more time. The estimate of damage assessment cost and income lost to 15 sites is **BZD$221,050**.

The Bliss Centre for the Performing Arts Institute of Creative Arts: This facility suffered moderate damages due to storm surge and wind impacts. The current estimate required for intervention repairs is **BZD$70,000.00**. A comprehensive repair & future preventative plan with price quotations is being explored in order to sustain and prevent any future hurricane impacts.

Museums of Belize: The following houses of cultures (HOC) buildings sustained minimal or no hurricane damages. Minimal damages included leaks, flooded waters, electrical damages and small fallen trees on some house of cultures compounds. Basic cleaning was done and the houses of cultures were up and running after hurricane Earl.

- Corozal HOC
- Banquitas HOC
- San Ignacio & Santa Elena HOC
- San Pedro HOC
- Stann Creek HOC
- Government House HOC
- Benque HOC

The Government House compound contained debris across the entire property from the storm surge. The garden area and trees located on the compound were affected by the wind and a number of trees were destroyed, uprooted or washed away. The yard and driveway sustained extreme damages; therefore, mitigation measures will be needed. The fence and front metal gate were severely damaged. The tree, which survived hurricanes in 1931, 1961 & 2010, fell and mitigation measures were made to save the historic tree in order to reposition and anchor the tree. Several personnel were hired to start with the clean-up campaign in order to restore the landscape of the Government House compound. It is estimated that a cost of **BZD$25,000** will be required to address landscaping, driveways and electrical systems for the Government House compound.

The Museum of Belize building was not affected by the hurricane except for flooding waters entering from the streets. Since Hurricane Richard in 2010, the roof and guttering were affected and minimal interventions were performed. Also, the porous bricks are brittle and need to be treated to prevent future water absorption. These problems were never addressed; therefore, a mitigation strategy to fix these problems will have to be explored to prevent any future effects of potential hurricanes.

The total damage to the Historic/Cultural Sites from Hurricane Earl is estimated at **BZD$316,050**.

3.2 Damage to Productive Sectors

3.2.1 Agriculture

(*Source: Ministry of Agriculture based on ground surveys and industry reports, Annex 7*)

Summary

This report is based on assessments and surveys completed up to day five following the passage of Hurricane Earl on the 3-4 August 2016. The losses calculated in this report are produce at farm gate prices unless otherwise explicitly mentioned in the body of the report. Damage recovery and needs assessment are still being compiled and is not included unless explicitly mentioned in the report. All dollar figures are in Belize dollars and the estimated total damage to the agricultural sector is **BZD$76,698,713** and outlined in Table 7.

This assessment is of crops only in producing stage and does not include a survey of out of season fruit trees for which the loss of trees are expected to be high in the Belize, Cayo and Stann Creek Districts. The extent of the damage may worsen over the next few weeks depending on the extent of foliar damage and standing water from the storm or subsequent flooding which is still ongoing in some areas affected by the hurricane. Approximately 1,200 famers were directly affected by the Hurricane; of that number, approximately 595 are corn farmers and 250 are vegetable farmers.

Districts	**Crops**	**Livestock**	**Cover Structure**	**Total**
Belize District	$4,097,878		$188,000	$4,285,878
Orange Walk	$6,089,520			$6,089,520
Corozal	$1,653,000			$1,653,000
Stann Creek	$29,048,524			$29,048,524
Cayo	$34,998,691	$100,000	$523,100	$35,621,791
Total	**$75,887,613**	**$100,000**	**$711,100**	**$76,698,713**

Table 7: Agricultural damages by District

Citrus

The Citrus groves in the Stann Creek and Cayo Districts sustained the most damage due mainly to fruit drop, tree loss, damage to housing and other farm infrastructure. It is important to recognize that additional fruit drop is expected as a delayed response to wind damage/foliar loss to the trees. At the time of this report, the estimated value of loss to citrus is **BZD$13,911,566.**

Corn

Mechanized commercial production of yellow and white corn is concentrated in the Cayo District namely; Spanish Lookout, Banana Bank and Cotton Tree/More Tomorrow areas, Indian Creek/Shipyard

in the Orange Walk District and Little Belize in the Corozal District. National acreage under cultivation for 2015 was estimated at 42,064 acres. Due to corn top damage this loss estimate presented could vary significantly if the kernels were not pollinated before the hurricane and this will only be evident in a few weeks time. This means that corn appearing as healthy may still not produce if they were not pollinated prior to the storm. Total estimated losses to mechanized corn production amount to 26,674.5 acres at a cost of **BZD$34,998,802**.

The small farmers in the Stann Creek district planted the most milpa corn country wide; approximately 87 acres amounting to **BZD$43,848** was loss. This will have significant effects in terms of food security and income generation for the most vulnerable families down south.

Banana

The Banana Industry was impacted due to strong winds experienced in the Stann Creek District as shown in Figure 3. It is clear from the assessment that the more significant damage occurred on the northern farms, specifically those in South Stann Creek with relatively minor damage to the southern farms around Bladen.

The acreage impacted is 1,107 acres of banana with an estimated value of loss and initial recovery of **BZD$14.984 million**.

Figure 3: Damage to banana in South Stann Creek

Vegetable and fruit

Products that sustained significant damage are tomatoes, sweet peppers, watermelon, cabbage, canteloupe, and papaya due to wind damage and water logging. Majority of the producers of these commodities are small to medium scale farmers located in Belize, Cayo and Orange Walk Districts. The socio economic impact is more significant for these farmers since they are highly dependent on these commodites for their livelihood.

In addition to product loss, a program to introduce growing of vegetable under protected covered structures (tropical green houses) has been severely impacted by the destruction from winds of the

structures. These must be urgently replaced as it allows farmers to grow vegetables with appropriate irrigation and minimal use of peticides or insecticides in the controlled enviroment.

Total estimated losses amounted to 252.57 acres at **BZD$6,330,603.5**.

Cover structures

Estimated value of losses for 103 protected cover structures is **BZD$717,650**. A total of 61 farmers cover structure were damaged or destroyed by the hurricane.

Sugarcane

The northern sugar cane production experienced minimal losses. This is estimated at 288 acres for a value of $316,800.00. The central sugar cane production, namely Santander Sugar sustained significant losses due to wind damage and standing water from storm and flood waters. An estimated 50k tons of cane will be lost amounting to $2 m and damages to roads, machinery and buildings amounted to 450,000. Estimated value of loss to sugar cane production and associated infrastructure is $2,766,800.

3.2.2 Tourism

(*Source: Ministry of Tourism and Civil Aviation, Annex 8*)

Hurricane Earl has been particularly damaging to the tourism sector due to the route the storm pursued. Earl passed over significant tourism investments in its trajectory across Belize. Hurricane Earl directly impacted approximately 70% of the country's total Hotel room stock, and caused cancellation and temporary closure to the entire Cruise sector.

3.2.2.1 Overview

Damage assessments were conducted in Ambergris Caye, Caye Caulker, Belize District, Cayo District and some offshore islands that were impacted. The assessments included damage to tourism infrastructure, loss of equipment, bookings, government taxes as well as projected losses to business during the rebuilding phase. Primary damage caused by Hurricane Earl has been mainly due to wind gusts and storm surge in the islands and along the coast of Belize City and wind and flood damage in the Belize River Valley and Cayo District.

3.2.2.2 Damage to Hotel Sector

The damage to the hotel sector was conducted on tourism infrastructure and loss of business due to closure or cancellation of bookings. There was damage to 56% of the National Hotel Stock in the affected areas. This represents 67% of the country's total room stock and is a severe impact on the country's capacity for overnight stays.

Ambergris Caye and Caye Caulker: Assessments of the Northern Islands revealed that the major impacts were caused by wind and storm surge as many properties on these two popular tourist destinations lost docks and beach front, with only a few reporting major structural damages or loss to room stock, equipment and furniture. While recovery works are well on the way, tourism stakeholders indicate that full recovery will take approximately 4 months. It is important to note that the subsequent cancellation of the Costa Maya Festival, due to the impacts of the storm on Ambergris Caye, caused the Northern Islands to incur an important loss of revenue due to cancellations of reservations.

Cayo District: Assessments of hotels in the western region of the country have revealed impacts primarily caused by wind and flooding during and after the passage of the Hurricane. While no significant loss has been reported on hotel room stock, considerable maintenance and repairs are foreseen to landscapes and facilities of properties especially near to riverbanks. Despite these challenges, the hotel sector in the Cayo District indicate a recovery time of just over 2 months in the most severe cases to return back to pre-storm status.

Belize District and Offshore Islands: Similar to the Northern Islands, the Belize District and Offshore Islands incurred damage primarily to wind and surge. Major hotels in Belize City, with docking facilities/marinas experienced severe structural damage, while also incurring some water damage to facilities and room stock.

In Rural Belize, major challenges remain downed trees, loss of power and utilities, however, clean-up efforts are projected to take approximately 2-3 months.

Economic Impact: While the initial assessment of the hotel sector has revealed that the major economic impact will be incurred due to the damage and loss to infrastructure, primarily docking facilities and beach front, and with considerable loss in revenue due to cancellations, the total economic impact of Hurricane Earl on our Hotel Sector, including loss of revenue from overnight tourist expenditure is estimated at $22.5 Million Belize Dollars, which covers infrastructure losses, estimated loss to revenue from bookings, estimated loss to hotel tax revenue, and estimated loss to tourist expenditure.

3.2.2.3 Damage and Losses to Tour Operations

The Post Hurricane Assessment of Tour Operators registered within affected zones affected by the Hurricane Earl were Belize City, Belize rural, Caye Caulker, San Pedro and Cayo.

The Tour operators in these regions represent 71.7% of the total licensed operators in the country. Based on the value of structural, equipment and marine infrastructure estimated losses are BZD$6,411,346. The figures below show losses by region:

- Belize City: $2,571,113
- Belize Rural: $404,636
- Caye Caulker: $750,468

- San Pedro: $1,516,436
- Cayo: $1,168,694

3.2.2.4 Losses in Cruise Tourism

Loss of Head Tax: Cruise calls to Belize were suspended on August 01, 2016 and did not resume until August 09, 2016. This reflected a loss 4 cruise ship calls. The data gathered here in has been collated from the BTB's department of Cruise and Destination Planning based on ship manifests and tour cancellations. The total revenue lost from the four Cruise Ships, which include Norwegian Escape, Carnival Glory, Carnival Magic and Liberty of the Seas, with an average total cruise passengers of 16,123 is $225,722.

Loss of passenger Expenditure: Based on the BREA[1] study for 2015, cruise passengers to Belize have an average expenditure of $77.87 USD or $155.74 BZD. The Cruise Expenditure is inclusive of ALL passenger expenditure including shore excursions, Restaurants and Bars, Souvenirs etc. Based on an average total disembarkation of 13,784 for the four cruise ships, the total revenue in passenger expenditure lost is $2,146,720.

Norwegian Escape would have made its first call to Belize; therefore, no data trend is collected to have an average. For this calculation, an 88% disembarkation rate was calculated based on trends of ships of that size.

Loss of Crew Expenditure: Based on BREA study 2015, crew passengers to Belize have an average expenditure of $52.34 USD or $104.68 BZD. Therefore, based on an average total disembarkation of 5,351, the total revenue in passenger expenditure lost is $560,143.

Cruise Line Expenditures: Total loss to fee collection to various Government agencies including Customs Department, Health, Belize Agricultural Health Authority, Immigration, Port Authority, etc. is $17,636. This excludes Head Tax estimations.

2.2.2.5 Summary

The aftermath of Hurricane Earl has resulted in critical losses to the tourism industry, Overall damages are recoverable and no loss of life was reported; however, full recovery of infrastructure is not expected until December of 2016. Re-booking figures will overlap with the start of the Tourism Season in November of 2016 so are therefore very low. Total Losses and Damages to industry are listed in Table 8.

[1] Business Research and Economic Advisors

Tourism Sub-Sector	Losses &Damages (BZD$)
Hotels	22,564,853
Tour Operators	6,411,346
Cruise	2,950,221
TOTAL	**31,926,420**

Table 8: Damages and Losses in the Tourism Sector

3.2.3 Aquaculture/Capture Fisheries

(Source: Environment and Solid Waste Committee, Annex 9)

3.2.3.1 Fishing Capacity Loss

An assessment on fishing capacity was conducted for 1,000 impacted fishermen. The assessment consisted of on-site surveys, which included field visits and the use of statistical data within the impacted fishing identified as areas. These include all areas near and north of Laughing Bird Caye. The losses to fishing capacity included loss of 15,634 lobster traps, 8,801 lobster shades, 29 fishing camps, 20 canoes, and 19 outboard engines. The total estimated loss for these is **BZD$2,291,775.**

3.2.3.2 Fisheries Production Loss

It is estimated that the area impacted by hurricane Earl represents 75% of the annual lobster production for Belize. Based on damage assessments on the fisheries sector as a result of previous hurricanes (Hurricane Richard and Hurricane Dean) which impacted the northern part of Belize, it will take approximately 5 months for the fishing capacity to recover. For example, in 2015, lobster production from August to December amounted to 466,073 lbs. The projected loss in lobster production of 85%, 80%, 75%, 50% and 25% for the months August to December respectively amounts to 313,571.44 lbs. This is broken down as Lobster tails: 162,427 lbs, Whole Lobster: 137,954, and Lobster Head Meat: 13,191 lbs. This loss of production is directly related to the loss of fishing capacity and the recovery in the affected areas. Based on this projected loss, and estimated values of Lobster Tails (BZD$16/lb), Whole Lobsters (BZD$10/lb), and lobster head meat (BZD$5/lb), the total loss in lobster production is **BZD$4,044,323**.

3.2.3.3 Export Earnings

The Northern Fishermen Cooperative Society averages export prices as: Lobster Tails (BZD$30/lb), Whole Lobsters (BZD$33/lb), and lobster head meat (BZD$6.5/lb). Thus, the total loss in export earnings from the loss of lobster production from August to December is **BZD$9,511,033**.

The total estimated loss to Aquaculture/Capture Fisheries is estimated as **BZD$15,847,131**. This includes loss to fishing capacity, fisheries production, and export earnings.

3.3 Infrastructure

3.3.1 Public Utilities

(*Source: Ministry of Energy, Public Utilities and Public Service based on reports from the utility companies, Annex 10*)

3.3.1.1 Electricity

The Belize Electricity Limited (BEL) reported that Belize City, Cayo, San Pedro, Belmopan, Ladyville and surrounding areas had no electricity after the storm due to extensive damages to the distribution infrastructure. Rough estimated value to address repairs and replacement is approximately **BZD$10,000,000**.

3.3.1.2 Water Supply

Assessments are ongoing.

3.3.1.2 Telecommunications and Communications

The Belize District was adversely affected by the loss or damage to Network Infrastructure including; (Mobile (cell sites) & computer/data/internet equipment), and Outside Plant Infrastructure (several cables down/destroyed) along with some Fiber distribution links which lead to Degraded/fluctuating service (Mobile, Internet) to Belize District, Cayes by the loss or damage to these facilities. While damages to the telecommunications network were minimal; the estimated cost of repairs to the entire sector is **BZD$1,783,363**.

3.3.1.3 Summary

The total estimated loss to public utilities is therefore **BZD$11,783,363**, which includes damages to electricity, water, and telecommunications/communications sectors.

3.3.2 Roads and Bridges

(*Source: Ministry of Works, Transport, and National Emergency Management*)

The Belize, Cayo and Stann Creek Districts were most affected by Hurricane Earl with level 1 damages to the road network from debris, minor rock slides, washout to bridges, scouring, damage to signs and cable bridges, and temporary flooding of sections of highways. In the Cayo District, there was flooding at the low-lying bridge in Santa Elena/San Ignacio and Iguana Creek Bridge as well as secondary roads accessing More Tomorrow and Manatee Roads (Coastal Road). The wooden bridge in San Ignacio across the Macal River remains closed and is seriously damaged. The Spanish lookout via Baking Pot Ferry is impassable as well as the Succotz Ferry which were closed due to flood waters. The Hammock Bridge in Calla Creek has been completely destroyed.

Most of the damages to the road network are minimal, and most of those damages are associated with converts washing out and debris on the road and costs associated with Hurricane Earl. While the damages to bridges and the road network were minimal, the estimated cost of repairs to the affected roads and bridges is estimated to be **BZD$2,944,695** (Table 9)**.** The repairs to the road network include the restoration of drainage profile and road structure.

District	Cost for Repairs
Belize	$656,270
Cayo	$1,387,045
Stann Creek	$633,680
10% Contingency	$267,700
Total	$2,944,695

Table 9: Hurricane Earl Damage Assessment to Roads and Bridges Summary

3.3.3 Piers

Ambergris Caye: The District Emergency Committee (DEC) responsible for Ambergris Caye and Caye Caulker conducted a survey of the affected piers after the all clear was issued by NEMO. The DEC inspected a total number of 252 piers in Ambergris Caye, of which 227 were found to be damaged. Of the 227, 123 were found to be completely destroyed. Based on the aerial survey conducted August 4th 2016, it was estimated that the damage to the remaining affected piers was at Level 3 (or about 60% damaged). Based on an average running length of 220 feet obtained from the database at the Lands and Surveys Department and the average value of $350 per running foot estimated by the Central Building Authority, the damages to piers are estimated at $14,275,800 for Ambergris Caye.

Caye Caulker: In Caye Caulker a similar survey was conducted where a total of 54 piers were inspected; 49 were found to be damaged. According to the DEC, of these, 30 were completely destroyed while 19 experienced level 3 damages. Based on an average running length of 160 feet, the estimated cost in damages to piers in Caye Caulker is $2,072,000.

Belize City: In Belize City there was damage to piers and marinas in the amount of $471,400. This results from a total length of 1,346 running feet of overwater infrastructure. This includes the Princess Hotel marina, Radisson Fort George marina and the Fisheries Department pier.

The total in damage to piers estimated so far is **BZD$16,819,200**.

3.4 Effects on the Environment, Fisheries and Forest

(Source: Environment and Solid Waste Committee, Annex 9)

The following sections summarize the damages to the environment by sector and include the estimated costs for damages resulting from Hurricane Earl.

3.4.1 Marine and Coastal Habitat

This section covers damage to marine and coastal habitat which includes coral reefs and beaches.

3.4.1.1 Coral Reefs

A rapid damage assessment was conducted on coral reefs and associated marine habitats in the impacted area from Hurricane Earl. These areas include:

- Bacalar Chico Marine Reserve
- Hol Chan Marine Reserve
- Caye Caulker Marine Reserve
- Half Moon Caye Natural Monument
- Turneffe Atoll Marine Reserve
- Glovers Reef Marine Reserve
- South Water Caye Marine Reserv
- Gladden Spit and Silk Cayes Marine Reserve
- Sapodilla Cayes Marine Reserve
- Port Honduras Marine Reserve

From the assessment conducted it is estimated that approximately 3% of corals were damaged, with the greatest extent of damage at Caye Caulker. The damage to corals in Caye Caulker was primarily mechanical damage to branching coral which are categorized as the more vulnerable species.

Additionally, the Bacalar Chico area reported beach damages affecting the main turtle nesting areas. Soft corals were also uprooted and washed on the beach. At the time of the survey, no damages to the seagrass beds was observed. The estimated cost of damage to the marine environment, including seagrass, and coastal mangroves is still being assessed.

3.4.1.2 Beaches

Beach loss was categorized in three ways, i.e. washing of beaches further ashore, further loss of already eroding beaches, and loss of beach where seawalls were present – in this case beach area is lost behind the existing seawall by undermining. In two main areas assessed for beach loss were Ambergris Caye and Caye Caulker. The estimated cost of replacement of beach material lost is $17. Based on assessments conducted in these two areas, the total estimated damage to beaches is **BZD$1,015,832**.

Ambergris Caye; In north Ambergris Caye the total beach material lost was estimated at 12,300 cubic yards. Within San Pedro Town limits the volume is estimated at 7,700 cubic yards; and in southern Ambergris Caye the figure is 20,050 cubic yards. The total for Ambergris Caye is therefore 40,050. The total damages to beaches in Ambergris Caye is estimated as BZD$680,850.

Caye Caulker: In Caye Caulker the volume of beach material lost is estimated at 17,631 cubic yards. This renders a total of BZD$334,982 in damages.

3.4.1.3 Infrastructure – Damage to Public and Protected Area Buildings

Total damage to infrastructure, both public and private, used in the environmental management in the marine area is estimated at BZD$385,000.00, which includes $170,000 in damages to the Fisheries Department Headquarters and $215,000 from infrastructure in the 9 surveyed Marine Protected Areas. The marine protected areas include Bacalar Chico, Caye Caulker, Glovers Reef, Southwater Caye, Sapodilla Cayes, Gladden Spit and Silk Cayes, Port Honduras, Lighthouse Reef, and Turneffe Atoll. An assessment of damages to infrastructure was also conducted on 5 national parks, 6 wildlife sanctuaries, 5 natural monuments and 1 privately held protected area. The total in damages to infrastructure for these other areas is approximately BZD$311,717. The total damages to infrastructure in marine and terrestrial protected areas is **BZD$696,717**.

The total damages to Marine and Coastal Habitat is estimated at **BZD$1,712,549**. This includes damages to beaches and to infrastructure in the Fisheries Department headquarters and marine and terrestrial protected areas.

3.4.2 Forest and Natural Vegetation

An assessment of forests was conducted within the areas impacted by the hurricane. This extends north to incorporate the Rio Bravo Conservation and Management Area and extends eastward to the coast within the Belize District. The area extends south to incorporate the Chiquibul Forest Reserve and National Park, extending east to the coastline incorporating Manatee and Sibun Forest Reserves. From a total forested area of 535,636 hectares, only 3% experienced extensive damage; the estimated cost of these damages has not been assessed. However, within the Rio Bravo Conservation and Management Area, there was 38% mortality of flora within the forested areas, were damaged. Of these, 60% were timber trees. Therefore, the estimated mortality was 23%, or 16,000 hectares. Using a baseline value of $2,000 per hectare for timber-forested areas, the estimated loss in forests is **BZD$7,360,000**.

3.4.3 Environmental Goods and Services Affected/Disrupted

3.4.3.1 Soil and Debris Disposal

The assessment soil and debris disposal was conducted through 1) a flyover of the impacted areas; 2) ground truth of onsite assessment teams in the impacted communities estimating and categorizing volumes of solid waste; 3) onsite monitoring of clean-up, collection, and disposal of waste within the

communities and at the designated disposal sites. Estimated volume of waste was calculated based on number of truckloads required to disposal of the waste, were one (1) truckload = 13 cubic yards of material (waste). Estimated cost of disposal was calculated using the cost of disposal of one truckload of waste, and varied depending on the availability of trucks and distance to the disposal site.

Based on the results of the assessment most of the solid waste was categorized as organic debris, specifically broken branches, limbs, leaves, and uprooted or fallen trees; most of the fallen and uprooted trees were fruit trees. In many communities, the fallen and uprooted trees were either piled in one location or left were they fell. Thus, the organic debris will increase the risk of forest fires in the dry season.

The approximate volume of solid waste generated by hurricane Earl and disposed of at designated disposal sites is estimated at 61,592 cubic yards. This estimated volume is approximately 4,738 truckloads of solid waste with an estimated disposal cost of $978,410.00 for transportation only. The projected cost of disposal further includes equipment mobilization, clearing, and other activities at the Mile 24 Sanitary Landfill; this is estimated to be $427,150. The total estimated cost for solid waste management is therefore estimated to be **BZD $1,406,260**. This figure does not include cost of labour and fuel and is expected to change as clean-up activities continue throughout the country.

3.4.4 Summary

The total in damages to the Environment Sector is approximately **BZD$10,478,809**. The breakdown can be seen in Table 10.

Environmental Sector/Areas Assessment for Economic Loss	**Estimated Direct Financial Cost (BZD$)**
Solid Waste	1,406,260
Marine Environment - Coral Reefs and Seagrass	TBD
Marine Environment - Beach Erosion	1,015,832
Forest - Timber Loss	7,360,000
Protected Areas (Infrastructure)	696,717
Riparian Forests	TBD
Mangrove Forests	TBD
Total	**10,478,809**

Table 10: Breakdown of Direct Financial Cost (Loss) to environmental sectors/areas

Annexes